



National Institute for Occupational Safety and Health
National Personal Protective Technology Laboratory
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Procedure No. CET-APRS-STP-CBRN-0313

Revision: 1.1

Date: 22 December 2005

DETERMINATION OF COMMUNICATION PERFORMANCE TEST FOR SPEECH
CONVEYANCE AND INTELLIGIBILITY OF CHEMICAL BIOLOGICAL RADIOLOGICAL
AND NUCLEAR (CBRN) FULL-FACEPIECE AIR-PURIFYING RESPIRATOR STANDARD
TEST PROCEDURE (STP)

1. PURPOSE

- 1.1. This test establishes the procedures for ensuring that the level of speech conveyance and intelligibility provided by the Communication Performance Test on Chemical Biological Radiological and Nuclear (CBRN) Full Facepiece Air-Purifying Respirator (APR) submitted for Approval, Extension of Approval, or examined during Certified Product Audits, meet the minimum certification standards set forth in this Standard Test Procedure (STP) as prescribed by 42 CFR, Part 84, Subpart G, Section 84.63(a)(c)(d); Volume 60, Number 110, June 8, 1995.
- 1.2. The purpose of this test is to quantify the performance and determine the rating of a CBRN APR to transmit intelligible speech of a human test subject. This is accomplished by a listener's ability to comprehend single words and provides an indication of speech transmission of the selected words. This procedure may be used to test communication performance of other types of Respiratory Protective Devices (RPD): Refer to the primary Statement of Standard for that particular RPD being tested for the communication performance requirements.

2. GENERAL

- 2.1. This STP describes the determination of the Communication Performance Tests for speech conveyance and intelligibility of the CBRN APR in sufficient detail that a person knowledgeable in the appropriate technical field can select equipment with the necessary resolution, select the appropriate human subject test panel, conduct the test, and determine whether or not the product passes the test.
- 2.2. The Communication Performance Test shall be performed through the use of the Modified Rhyme Test (MRT) to evaluate a listener's ability to comprehend single words from a speaker. Both listeners and speakers shall be in combinations of masked and unmasked postures during the MRT to provide an indication of speech transmission and intelligibility.

Approvals:	<u>1st</u> Level	<u>2nd</u> Level	<u>3rd</u> Level
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- 2.3. This test is considered a human factors test that requires participation of 8 human subjects to quantify the performance rating of a CBRN APR to transmit intelligible speech.

3. EQUIPMENT/MATERIALS

3.1. Test Equipment

- 3.1.1. Measuring tape, foot & inch or meter & centimeter graduations, minimum 16 feet (4.9 meter) length, or equivalent.
- 3.1.2. Test laboratory that permits an unobstructed 10 ft +1/-0 ft (3.05 m +0.3/-0 m) distance between talker and listener groups when facing one another. Figure 1 contains a diagram of the subject and equipment positioning for the Modified Rhyme Test setup.

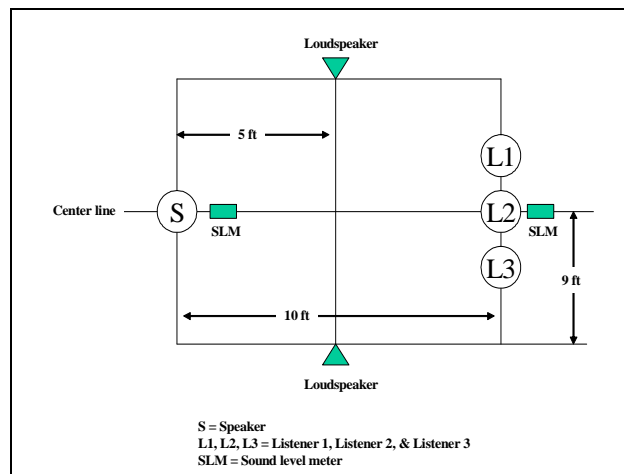


Figure 1. Modified Rhyme Test setup diagram

- 3.1.3. Noise generator Type 1405 (Bruel & Kjaer) or equivalent for producing pink noise in the frequency range of 20.0 Hz to 50.0 kHz. Figure 2 is an illustration of a noise generator.



Figure 2. Bruel & Kjaer Type 1405 Noise Generator

- 3.1.4. The stereo amplifier with two loudspeakers is positioned midway between speaker and listeners that is used to transmit and amplify the background noise. Details of the exact positioning of the stereo and speaker equipment are further defined in Section 5.3.2.
- 3.1.5. Two Type 2 digital sound level meters (Sper Scientific, LTD, Model 840029) with an “A” weighting decibel scale of 30 to 130 dB or equivalent. Figure 3 depicts one sound level meter.



Figure 3. Sper Scientific LTD digital sound level meter, Model 840029

- 3.1.6. Sper Scientific, LTD Acoustical calibrator (model 840031) or equivalent, illustrated in Figure 4, is used in to calibrate the sound level meters.



Figure 4. Acoustical calibrator (Sper Scientific model 840031)

- 3.1.7. Six-word lists of the Modified Rhyme Test (MRT) as listed in Table 1. These six word lists are separated onto individual sheets to be used by the speakers during the test and are in Appendix A, CBRN APR Communication Performance Word List Test Sheets. Additional test word lists can be developed according to Table 2 of ANSI S3.2 - 1989, *Method for Measuring the Intelligibility of Speech over Communication Systems*.

3.1.8. Test listeners's multiple choice answer sheets as shown in Appendix B or equivalent. Modified Rhyme Test listener responses may also be recorded and scored using personal computers that have been programmed for this application; otherwise, the manual method using the multiple choice answer sheets must be employed described in Section 5.6

3.1.9. Audio tape recorder or sound recording device for recording speech.

Table 1. The six-word lists of the Modified Rhyme Test

List 1	List 2	List 3	List 4	List 5	List 6
1. but	1. bus	1. bug	1. bun	1. buck	1. buff
2. kit	2. kick	2. kin	2. kill	2. king	2. kid
3. peak	3. peas	3. peach	3. peace	3. peat	3. peal
4. pig	4. fig	4. rig	4. big	4. dig	4. wig
5. cold	5. hold	5. gold	5. told	5. fold	5. sold
6. sick	6. lick	6. tick	6. kick	6. wick	6. pick
7. pat	7. pass	7. pan	7. pad	7. pack	7. path
8. beat	8. beach	8. beak	8. bean	8. bead	8. beam
9. hot	9. pot	9. got	9. lot	9. not	9. tot
10. fit	10. bit	10. hit	10. kit	10. wit	10. sit
11. sung	11. sub	11. sup	11. sum	11. sun	11. sud
12. sent	12. went	12. rent	12. bent	12. tent	12. dent
13. rest	13. west	13. best	13. vest	13. test	13. nest
14. mat	14. map	14. math	14. man	14. mad	14. mass
15. top	15. cop	15. hop	15. mop	15. pop	15. shop
16. sack	16. sap	16. sad	16. sat	16. sass	16. sag
17. day	17. pay	17. gay	17. say	17. way	17. may
18. heal	18. heath	18. heap	18. hear	18. heat	18. heave
19. name	19. tame	19. fame	19. game	19. same	19. came
20. pay	20. pale	20. page	20. pave	20. pane	20. pace
21. must	21. gust	21. bust	21. dust	21. just	21. rust
22. pun	22. pus	22. puff	22. puck	22. pup	22. pub
23. hen	23. then	23. ten	23. men	23. pen	23. den
24. cud	24. cuss	24. cup	24. cuff	24. cut	24. cub
25. book	25. cook	25. took	25. hook	25. shook	25. look
26. late	26. lace	26. lake	26. lane	26. lay	26. lame
27. led	27. bed	27. shed	27. fed	27. red	27. wed
28. same	28. save	28. safe	28. sale	28. sane	28. sake
29. pin	29. pit	29. pig	29. pip	29. pill	29. pick
30. feel	30. reel	30. eel	30. peel	30. keel	30. heel
31. soil	31. boil	31. toil	31. coil	31. oil	31. foil
32. fizz	32. fib	32. fill	32. fit	32. fig	32. fin
33. park	33. bark	33. lark	33. mark	33. hark	33. dark
34. bash	34. bad	34. bath	34. bat	34. ban	34. back
35. till	35. fill	35. will	35. bill	35. hill	35. kill
36. male	36. gale	36. tale	36. bale	36. pale	36. sale
37. dud	37. duck	37. dung	37. dub	37. dun	37. dug
38. sin	38. sit	38. sill	38. sing	38. sick	38. sip
39. tack	39. tap	39. tang	39. tam	39. tab	39. tan
40. case	40. cane	40. cave	40. cape	40. cake	40. came
41. bang	41. sang	41. rang	41. hang	41. fang	41. gang
42. thaw	42. saw	42. jaw	42. law	42. raw	42. paw
43. ray	43. race	43. raze	43. rake	43. rate	43. rave
44. dig	44. dim	44. dip	44. dill	44. did	44. din
45. team	45. teak	45. teal	45. tease	45. teach	45. tear
46. win	46. din	46. pin	46. fin	46. sin	46. tin
47. seek	47. seethe	47. seem	47. seen	47. seed	47. seep
48. bun	48. run	48. fun	48. gun	48. sun	48. nun
49. feat	49. meat	49. heat	49. seat	49. neat	49. beat
50. sip	50. dip	50. rip	50. hip	50. tip	50. lip

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3.2. Human Test Subjects

- 3.2.1. Test administrator(s): Shall have successfully completed the CDC/ATSDR Scientific Ethics Training, DHHS/NIH Human Participant Protections Education for Research Teams or an equivalent course. Note: The NIOSH Human Subject Review Board will deem if courses are equivalent.
- 3.2.2. Eight human subjects are required for this test. All procedures and requirements specified in the NIOSH Human Subject Review Board (HSRB) Protocol HSRB-02-NPPTL-04XP entitled, "Determination of Speech Communications Performance of Full-Facepiece Air-Purifying Respirators" shall be followed and met. Informed consent will be obtained from each volunteer upon completion of the Volunteer Agreement Affidavit and Volunteer Agreement Affidavit Explanation contained in Protocol No. HSRB-02-NPPTL-04XP.
- 3.2.3. The eight test subjects shall be divided into a listener group comprised of one female and two males (three subjects) and a speaker group consisting of one female and four males (five subjects). If only one female is available from the human test subject pool, that female test subject will be used in the listening group. The test administrator may use a female colleague as a speaker if no second female subject is available from the human test subject pool.
- 3.2.4. All test speakers and listeners shall have English as their native language.
- 3.2.5. The eight test subjects shall be trained in the donning and usage of the CBRN APR per manufacturer's instructions by the test administrator.
- 3.2.6. Each subject shall be sized and fitted for the CBRN APR per manufacturer's instructions. Where an individual is qualified to wear multiple sizes of the CBRN APR, the subject shall select the respirator size that provides the most comfortable fit.
- 3.2.7. Each speaker shall randomly be assigned a "Speaker Number" to be used during the actual MRT.
- 3.2.8. Each listener shall randomly be assigned a "Listener Number" to be used during the actual MRT.
- 3.2.9. The subjects participating as listeners shall have normal hearing as defined in Section 5.3 of ANSI S3.2 - 1989, *Method for Measuring the Intelligibility of Speech over Communication Systems*, in the range of 500.0 Hz to 3000.0 Hz. A normal hearing test shall be administered by the test administrator to ensure eligibility of human subjects.
- 3.2.10. The five test speakers shall not have facial hair or any conditions that may cause interference with the seal of the respirator facepiece. In addition, these subjects shall have no obvious or strong regional accents.

3.3. Required CBRN APR Test Items.

The total number of CBRN APRs required for the Communications Performance Test will depend upon the number of sizes available for the APR. The quantity must be sufficient to meet the sizing of eight subjects without having to sanitize a particular APR so that another subject could use it during the test trail.

3.3.1. If an APR is available in sizes of small, medium, and large, the manufacturer shall supply a minimum of four small, five medium, and three large facepieces.

3.3.2. If an APR is available in two sizes, there shall be six of each size available for the testing.

3.3.3. There shall be nine CBRN APRs of each one-size mask system.

4. TESTING REQUIREMENTS AND CONDITIONS

4.1. Prior to beginning any testing, all measuring equipment to be used must have been calibrated in accordance with the manufacturer's calibration procedure and schedule. At a minimum, all measuring equipment utilized for this testing must have been calibrated within the preceding 12 months using a method traceable to the National Institute of Standards and Technology (NIST).

4.2. Normal laboratory safety practices must be observed. This includes safety precautions described in the current Bruceton Facility Laboratory Safety Manual or site-specific procedures that are applicable to the health and safety requirements.

4.2.1. All electrical equipment cables and wires must be fastened securely to the floor by tape or some form of cover to eliminate trip hazards.

4.2.2. Worktables must be maintained free of clutter and non-essential test equipment.

4.2.3. All large test equipment such as the stereo amplifier, speakers, personal computers (optional method for listeners' to answer) and noise generator shall be securely fastened to eliminate toppling hazards.

5. PROCEDURES

Note: Reference Section 3. for equipment, model numbers and manufacturers. For calibration purposes use those described in the manufacturer's operation and maintenance manuals.

5.1. This procedures describes the Communication Performance Test for Speech Conveyance and Intelligibility for ensuring that the level of face to face voice communications provided by the CBRN APR meets or exceeds the requirements outlined in the Statement of Standard for Chemical, Biological, Radiological and Nuclear (CBRN) Full Facepiece Air-Purifying Respirator (APR), dated March 7, 2003 with Revision 2, April 4, 2003.

Other types of CBRN RPD may be tested for Communication Performance using this procedure: Refer to the primary Statement of Standard for the CBRN RPD being tested for the Communication Performance requirements. This procedure describes the required sample size, test equipment, MRT procedure and data collection methods for conducting the test on the CBRN APR.

5.2. Test Material/Items

5.2.1. Test Items

Indicate on the Test Data Analysis Sheet in Appendix C the following general pretest information about the APR:

- NIOSH Application Number
- Name of Manufacturer
- Type of RPD being Tested (APR, APR Escape, PAPR, ETC):
- Model Number/Name of RPD
- Model Number/Name of Canister
- Date Arrived
- Date Tested
- General Condition of Packaging
- Appearance of CBRN APRs and Canisters
- Any Specific Physical Anomalies

5.2.2. Numbering of Test Items

All CBRN APR items shall be individually numbered with an indelible pen or tagged in a sequence that the number can be correlated to the NIOSH application number, manufacturer, and model number so it can be tracked throughout the series of tests. For example, the number sequence can be CM1S1, CM1S2..., CM1M1, CM1M2..., or CM1L1, CM1L2..., etc. The CM1S1 meaning CBRN APR, Manufacture #1, Small Respirator 1 and CM1L2 meaning CBRN APR, Manufacture #1, Large Respirator 2. The test administrator shall mark on each Test Listener Data Sheet, Appendix B, the individual CBRN APR number that each Listener and Speaker is wearing (If worn) during that particular test run.

5.3. Test Equipment Set-Up.

5.3.1. Room Selection.

The room selected to perform the MRT shall be of ample size to comfortably house all the test equipment indicated in Figure 1 and the personnel associated with the test. It shall be free of external noise interference and be kept at a comfortable ambient temperature of approximately 72°F/22.°C.

5.3.2. Equipment Positioning

The test equipment shall be arranged in accordance with the diagram of Figure 1. The loudspeakers shall be positioned such that their forward axes are oriented toward one another at a height of approximately 29.5 in (74.9 cm) from the floor and they are 9 ft +0.5/-0 ft (2.7 m +0.2/-0 m) from the center of the sound field between the test speaker and listeners. The stereo amplifier and noise generator (Figure 2) shall be securely mounted on a stand convenient for connecting the speakers and clear of being toppled. The personal computers (optional) will be placed directly in front of the listeners with an approximate distance of 1 foot space between listeners.

5.4. Training of the MRT Speakers.

- 5.4.1. Without the listeners in the room, one subject at a time will be seated in the MRT speaker's position and be given a single MRT word list from Appendix A. A sound level meter will be positioned in front of the speaker within his or her sight to provide feedback concerning the loudness of their voice during reading of the word list. The sound level meter shall be set to display "A"-weighted sound levels.
- 5.4.2. The test administrator shall be seated in the center MRT listener's position and instruct the speaker to begin reading the word list using the carrier phrase "The word is (list word)" and a voice level of 75 dBA to 85 dBA as indicated on the sound level meter positioned before them. In order to ensure that the listeners know which MRT response subgroup of words to review, the speaker may also use the carrier phrase "The first word is (list word)," with the numerical order increasing with each successive list word. The speaker shall be instructed to read without placing unusual emphasis on any stimulus word at a rate of approximately one word every 6 seconds. In addition, the speaker shall be directed to communicate each word without using any visual gestures such as hand signals and without repeating any of the list words.
- 5.4.3. During reading of the word list, the test administrator will monitor the "A"-weighted output volume of the speaker at the listening position and provide feedback as to the loudness, clarity, and rate of the speaker's performance throughout the reading of the word list. After completing the entire word list, the speaker will complete a minimum of two additional MRT words lists. Additional training will be done if warranted per the judgment of the test administrator. These procedures will be completed without the use of a respirator and without any background noise above ambient conditions.
- 5.4.4. Additionally, training with the addition of background noise of 60 dBA \pm 2 dBA consisting of a broadband "pink" noise will also be completed according to the above procedures.

5.5. Training of the MRT Listeners.

- 5.5.1. The three test listeners shall be seated facing a single test speaker at a distance of 10 ft (3.05 m). The listeners shall be seated next to one another with

approximately one foot of distance between them. Each listener will be given a multiple choice CBRN APR Communications Performance Test Listener Data Sheet for recording his or her responses. Appendix B is an example of a CBRN APR Communications Performance Test Listener Data Sheet; however, this data sheet only corresponds to the word lists in Table 1 and in Appendix A.

Additional test word lists can be developed according to Table 2 of ANSI S3.2 - 1989, *Method for Measuring the Intelligibility of Speech over Communication Systems.*; thus, a corresponding CBRN APR Communications Performance Test Listener Data Sheet must be developed for the additional test word lists.

Alternate means for recording MRT listener responses such as a computer and monitor are acceptable.

- 5.5.2. As a group, listeners will be instructed to listen attentively as the speaker reads 50 words to them each with a phrase such as “The word is (list word)” or “The first word is (list word),” with the numerical order increasing with each successive list word. The listeners shall be directed to select or make a best guess of the word that was perceived to be spoken from the six possible response words provided to them on the Test Listener Data Sheet without copying another listener’s answer. Listeners shall also be instructed to provide a “thumbs-up” hand signal to the speaker as a cue to say the next stimulus word.
- 5.5.3. An MRT word list will be provided to a trained speaker. The speaker will be instructed to communicate the word list to the listeners as was done during speaker training. During reading of the word list the administrator will monitor the A-weighted output volume of the speaker at the listening position and provide feedback as to the loudness, clarity, and rate of the speaker’s performance throughout the reading of the word list. In addition, the test administrator will monitor the actions of the listener group and provide additional instructions as needed. After completing the entire word list, a minimum of two additional MRT words lists will be presented to the listeners using two different test speakers. Additional training will be done if warranted per the judgment of the test administrator. These procedures will be completed without the use of a respirator and without any background noise above ambient conditions.
- 5.5.4. Additionally, listener training with the addition of background noise of 60 dBA \pm 2 dBA consisting of a broadband “pink” noise will also be completed according to the above procedures.

5.6. Conducting the Test.

- 5.6.1. The test material shall be the reading of one complete MRT word list as contained in Appendix A.
- 5.6.2. Both sound level meters shall be turned on and calibrated prior to subjects entering the test room.
- 5.6.3. The noise generator shall be turned on and set to produce pink noise. The output of the noise generator shall be adjusted to produce a signal strength of 60 dBA as

measured by the sound level meter at the listener's head position without listeners present.

- 5.6.4. The three test listeners shall be seated facing a single test speaker at a distance of 10 ft (3.05 m).
- 5.6.5. A test speaker will be positioned in the speaking position and present one complete MRT word list to the listening panel. A different speaker shall then be used to present the next MRT trial. Test speakers will continue to rotate among the speaker test panel until all trials have been complete.
- 5.6.6. Data will be obtained without the respirator and with the respirator worn and operated per the manufacturer's instructions by both speakers and listeners. All conditions shall be randomly assigned and a different word list shall be used for each test. An example test matrix of the MRT conditions is provided in Table 2 to assist the test administrator in establishing the sequence of testing.

Table 2. MRT Trial Matrix

MRT #	Speaker	Speaker Condition	Listeners' Condition	Word list
1	1	No mask	No mask	1
2	2	No mask	No mask	3
3	3	Masked	Masked	5
4	4	Masked	Masked	6
5	5	No mask	No mask	4
6	2	Masked	Masked	2
7	4	No mask	No mask	5
8	1	Masked	Masked	1
9	5	Masked	Masked	3
10	3	No mask	No mask	6

- 5.6.7. Background noise levels shall be monitored at the listener's head position and recorded at the beginning, middle, and end of each MRT session.
- 5.6.8. The speech of the test speakers shall be audio recorded and monitored closely during the tests to determine if the speakers conform to the word list specified for each test. The test administrators shall note any improperly pronounced or misspoken words by the speakers so they can be taken into account during data analysis.
- 5.6.9. A total of 10 MRT trials shall be performed. The 10 trials will result in a total of 15 MRT scores (five per listener) for the unworn mask condition and 15 scores for the worn condition.

5.7. Data Analysis.

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5.7.1. Use pages 2-3 of Appendix C, CBRN APR Communication Performance Test Data Analysis Sheets, to assist with the analysis of the ten MRT for each listener.

5.7.2. The number of correct responses shall be adjusted for chance or guessing made possible by the multiple-choice form of the answer sheet using the equation:

$$\text{Adjusted Score} = \frac{\text{Number of Correct Listener Responses} - \frac{\text{Number of Wrong Listener Responses}}{5}}$$

5.7.3. Determine the Number of Words Spoken Correctly by the speakers from either the Test Administrators notes or if necessary, by listening to the Audio recorder tapes.

5.7.4. Listener performance on the MRT shall be scored in terms of the percentage of words correctly identified using the equation for both the masked and unmasked posture:

$$\% \text{ Correct} = (\text{Adjusted Score} / \text{Number of Words Spoken Correctly}) * 100$$

5.7.5. Average Unmasked and Average Masked % Correct Scores shall be calculated for each individual listener.

5.7.6. Each individual listener's Average Masked % Correct Score shall be divided by their Average Unmasked % Correct Score to calculate a Performance Rating using the equation:

$$\text{Performance Rating (\%)} = \left(\frac{\text{Average Masked \% Correct Score}}{\text{Average Unmasked \% Correct Score}} \right) \times 100$$

5.7.7. The performance rating of all listeners shall then be averaged to determine the Overall Performance Rating of the CBRN APR using the following Equation:

$$\text{Overall Performance Rating (\%)} = \frac{\text{Performance Rating (\%)}_{L1} + \text{Performance Rating (\%)}_{L2} + \text{Performance Rating (\%)}_{L3}}{3}$$

6. PASS/FAIL CRITERIA

6.1. The criterion for passing this test is set forth in 42 CFR, Part 84, Subpart G, Section 84.63(a)(c)(d); Volume 60, Number 110, June 8, 1995.

6.2. This test establishes the standard procedure for ensuring that:

84.63 Test requirements; general.

(a) Each respirator and respirator component shall when tested by the applicant and by

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the Institute, meet the applicable requirements set forth in subparts H through L of this part.

(c) In addition to the minimum requirements set forth in subparts H through L of this part, the Institute reserves the right to require, as a further condition of approval, any additional requirements deemed necessary to establish the quality, effectiveness, and safety of any respirator used as protection against hazardous atmospheres.

(d) Where it is determined after receipt of an application that additional requirements will be required for approval, the Institute will notify the applicant in writing of these additional requirements, and necessary examinations, inspections, or tests, stating generally the reasons for such requirements, examinations, inspections, or tests.

- 6.3. A candidate CBRN APR in accordance with the Statement of Standard for Chemical Biological Radiological and Nuclear (CBRN) Full Facepiece Air Purifying Respirators (APR), March 7, 2003 with Revision 2, April 4, 2003 must obtain an Overall Performance Rating greater than or equal to 70% to meet the Communication requirement. Other types of RPD may be tested for Communication performance using this procedure: Refer to the primary Statement of Standard for that particular RPD being tested for the Communication performance requirements.

7. RECORDS/TEST SHEETS

- 7.1. All test data shall be recorded on the CBRN APR Communications Performance Test Data Analysis Sheets contained in Appendix C or an equivalent electronic format (spreadsheet) indicating key parameters of the test.
- 7.2. All videotapes and photographs of the actual test being performed, or of the tested equipment shall be maintained in the task file as part of the permanent record.
- 7.3. All equipment failing any portion of this test will be handled as follows:
 - 7.3.1. If the failure occurs on a new certification application, or extension of approval application, send a test report to the Certification, Evaluation and Testing Section Chief and prepare the hardware for return to the manufacture.
 - 7.3.2. If the failure occurs on hardware examined under an Off-the Shelf Audit, the hardware will be examined by a technician and the Certification, Evaluation and Testing Section Chief for cause. All equipment failing any portion of this test may be sent to the manufacturer for examination and then returned to NIOSH. However, the hardware tested shall be held at the testing laboratory until authorized for release by the Certification, Evaluation and Testing Section Chief, or designee, following the standard operating procedures outlined in the Procedure for Scheduling, and *Processing Post-Certification Product Audits, RB-SOP-0005-00*.

Appendix A
CBRN APR Communication Performance Word List Test Sheets

List 1A

- | | |
|-----------------------------|-----------------------------|
| 1. The word is but | 26. The word is late |
| 2. The word is kit | 27. The word is led |
| 3. The word is peak | 28. The word is same |
| 4. The word is pig | 29. The word is pin |
| 5. The word is cold | 30. The word is feel |
| 6. The word is sick | 31. The word is soil |
| 7. The word is pat | 32. The word is fizz |
| 8. The word is beat | 33. The word is park |
| 9. The word is hot | 34. The word is bash |
| 10. The word is fit | 35. The word is till |
| 11. The word is sung | 36. The word is male |
| 12. The word is sent | 37. The word is dud |
| 13. The word is rest | 38. The word is sin |
| 14. The word is mat | 39. The word is tack |
| 15. The word is top | 40. The word is case |
| 16. The word is sack | 41. The word is bang |
| 17. The word is day | 42. The word is thaw |
| 18. The word is heal | 43. The word is ray |
| 19. The word is name | 44. The word is dig |
| 20. The word is pay | 45. The word is team |
| 21. The word is must | 46. The word is win |
| 22. The word is pun | 47. The word is seek |
| 23. The word is hen | 48. The word is bun |
| 24. The word is cud | 49. The word is feat |
| 25. The word is book | 50. The word is sip |

Appendix A
(Cont.)**List 2A**

1. The word is **bus**
2. The word is **kick**
3. The word is **peas**
4. The word is **fig**
5. The word is **hold**
6. The word is **lick**
7. The word is **pass**
8. The word is **beach**
9. The word is **pot**
10. The word is **bit**
11. The word is **sub**
12. The word is **went**
13. The word is **west**
14. The word is **map**
15. The word is **cop**
16. The word is **sap**
17. The word is **pay**
18. The word is **heath**
19. The word is **tame**
20. The word is **pale**
21. The word is **gust**
22. The word is **pus**
23. The word is **then**
24. The word is **cuss**
25. The word is **cook**
26. The word is **lace**
27. The word is **bed**
28. The word is **save**
29. The word is **pit**
30. The word is **reel**
31. The word is **boil**
32. The word is **fib**
33. The word is **bark**
34. The word is **bad**
35. The word is **fill**
36. The word is **gale**
37. The word is **duck**
38. The word is **sit**
39. The word is **tap**
40. The word is **cane**
41. The word is **sang**
42. The word is **saw**
43. The word is **race**
44. The word is **dim**
45. The word is **teak**
46. The word is **din**
47. The word is **seethe**
48. The word is **run**
49. The word is **meat**
50. The word is **dip**

Appendix A
(Cont.)**List 3A**

1. The word is **bug**
2. The word is **kin**
3. The word is **peach**
4. The word is **rig**
5. The word is **gold**
6. The word is **tick**
7. The word is **pan**
8. The word is **beak**
9. The word is **got**
10. The word is **hit**
11. The word is **sup**
12. The word is **rent**
13. The word is **best**
14. The word is **math**
15. The word is **hop**
16. The word is **sad**
17. The word is **gay**
18. The word is **heap**
19. The word is **fame**
20. The word is **page**
21. The word is **bust**
22. The word is **puff**
23. The word is **ten**
24. The word is **cup**
25. The word is **took**
26. The word is **lake**
27. The word is **shed**
28. The word is **safe**
29. The word is **pig**
30. The word is **eel**
31. The word is **toil**
32. The word is **fill**
33. The word is **lark**
34. The word is **bath**
35. The word is **will**
36. The word is **tale**
37. The word is **dung**
38. The word is **sill**
39. The word is **tang**
40. The word is **cave**
41. The word is **rang**
42. The word is **jaw**
43. The word is **raze**
44. The word is **dip**
45. The word is **teal**
46. The word is **pin**
47. The word is **seem**
48. The word is **fun**
49. The word is **heat**
50. The word is **rip**

Appendix A
(Cont.)**List 4A**

1. The word is **bun**
2. The word is **kill**
3. The word is **peace**
4. The word is **big**
5. The word is **told**
6. The word is **kick**
7. The word is **pad**
8. The word is **bean**
9. The word is **lot**
10. The word is **kit**
11. The word is **sum**
12. The word is **bent**
13. The word is **vest**
14. The word is **man**
15. The word is **mop**
16. The word is **sat**
17. The word is **say**
18. The word is **hear**
19. The word is **game**
20. The word is **pave**
21. The word is **dust**
22. The word is **puck**
23. The word is **men**
24. The word is **cuff**
25. The word is **hook**
26. The word is **lane**
27. The word is **fed**
28. The word is **sale**
29. The word is **pip**
30. The word is **peel**
31. The word is **coil**
32. The word is **fit**
33. The word is **mark**
34. The word is **bat**
35. The word is **bill**
36. The word is **bale**
37. The word is **dub**
38. The word is **sing**
39. The word is **tam**
40. The word is **cape**
41. The word is **hang**
42. The word is **law**
43. The word is **rake**
44. The word is **dill**
45. The word is **tease**
46. The word is **fin**
47. The word is **seen**
48. The word is **gun**
49. The word is **seat**
50. The word is **hip**

Appendix A
(Cont.)**List 5A**

1. The word is **buck**
2. The word is **king**
3. The word is **peat**
4. The word is **dig**
5. The word is **fold**
6. The word is **wick**
7. The word is **pack**
8. The word is **bead**
9. The word is **not**
10. The word is **wit**
11. The word is **sun**
12. The word is **tent**
13. The word is **test**
14. The word is **mad**
15. The word is **pop**
16. The word is **sass**
17. The word is **way**
18. The word is **heat**
19. The word is **same**
20. The word is **pane**
21. The word is **just**
22. The word is **pup**
23. The word is **pen**
24. The word is **cut**
25. The word is **shook**
26. The word is **lay**
27. The word is **red**
28. The word is **sane**
29. The word is **pill**
30. The word is **keel**
31. The word is **oil**
32. The word is **fig**
33. The word is **hark**
34. The word is **ban**
35. The word is **hill**
36. The word is **pale**
37. The word is **dun**
38. The word is **sick**
39. The word is **tab**
40. The word is **cake**
41. The word is **fang**
42. The word is **raw**
43. The word is **rate**
44. The word is **did**
45. The word is **teach**
46. The word is **sin**
47. The word is **seed**
48. The word is **sun**
49. The word is **neat**
50. The word is **tip**

Appendix A
(Cont.)**List 6A**

1. The word is **buff**
2. The word is **kid**
3. The word is **peal**
4. The word is **wig**
5. The word is **sold**
6. The word is **pick**
7. The word is **path**
8. The word is **beam**
9. The word is **tot**
10. The word is **sit**
11. The word is **sud**
12. The word is **dent**
13. The word is **nest**
14. The word is **mass**
15. The word is **shop**
16. The word is **sag**
17. The word is **may**
18. The word is **heave**
19. The word is **came**
20. The word is **pace**
21. The word is **rust**
22. The word is **pub**
23. The word is **den**
24. The word is **cub**
25. The word is **look**
26. The word is **lame**
27. The word is **wed**
28. The word is **sake**
29. The word is **pick**
30. The word is **heel**
31. The word is **foil**
32. The word is **fin**
33. The word is **dark**
34. The word is **back**
35. The word is **kill**
36. The word is **sale**
37. The word is **dug**
38. The word is **sip**
39. The word is **tan**
40. The word is **came**
41. The word is **gang**
42. The word is **paw**
43. The word is **rave**
44. The word is **din**
45. The word is **tear**
46. The word is **tin**
47. The word is **seep**
48. The word is **nun**
49. The word is **beat**
50. The word is **lip**

Appendix B

CBRN APR Communication Performance Test Listener Data Sheet

NIOSH Application Number _____ Date: _____
 Respirator Manufacture: _____ ; MRT/Sheet# _____
 Respirator Type: _____ ; Speakers Respirator Number, if worn _____ (Indicate if unworn)
 Listener's Respirator (circle one): Unworn Worn If Worn, Listeners Respirator Number _____
 Listener #: _____ Listening Position: _____ Speaker #: _____ MRT Word List#: _____

1	but bug bus buff bun buck	14	map mat math mad mass man	27	wed fed bed led shed red	40	cake came Cave cane case cape
2	kin kid kick king kit kill	15	hop cop shop mop pop top	28	sane sake safe save same sale	41	fang bang hang sang gang rang
3	peak peach peas peal peace peat	16	sack sad sap sag sat sass	29	pit pin pig pill pick pip	42	law saw paw jaw raw thaw
4	dig wig big fig pig rig	17	say pay may gay way day	30	heel peel keel feel eel reel	43	rake rate ray raze race rave
5	fold sold gold hold cold told	18	heath heave heap heat heal hear	31	toil boil foil coil oil soil	44	dip dim din dill did dig
6	kick lick sick tick wick pick	19	tame came fame same name game	32	fig fizz fit fib fin fill	45	tear teal teak team tease teach
7	path pack pass pat pad pan	20	page pane pace pave pale pay	33	mark bark dark lark hark park	46	tin fin sin win pin din
8	beat beak beach beam bean bead	21	dust gust must bust just rust	34	bash bat ban back bath bad	47	seethe seek seen seed seep seem
9	pot hot lot not tot got	22	pun puff pup pub pus puck	35	will hill kill bill fill till	48	run bun fun sun nun gun
10	fit hit bit sit kit wit	23	then den ten pen hen men	36	pale sale bale gale male tale	49	neat beat seat meat feat heat
11	sup sub sud sum sun sung	24	cuss cud cup cut cub cuff	37	duck dud dung dun dug dub	50	lip hip dip sip rip tip
12	dent tent rent went sent bent	25	hook shook book took cook look	38	sit sip sill sick sin sing	Score	
13	best west nest vest test rest	26	late lake lay lame lane lace	39	tack tan tab tang tam tap		

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Appendix C

CBRN APR Communication Performance Test Data Analysis Sheets

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NIOSH Application Number _____

Name of Manufacturer _____

Type of RPD being Tested (APR, APR Escape, PAPR, ETC): _____

Model Number of CBRN APR _____

Model Number of Canister _____

Date Arrived _____

Date Tested _____

General Condition of Packaging _____

Appearance of CBRN APRs and Canisters _____

Any Specific Physical Anomalies _____

Type of Test being Conducted _____

Overall Performance Rating (%) :
$$\frac{\text{Performance Rating (\%)}_{L1} + \text{Performance Rating (\%)}_{L2} + \text{Performance Rating (\%)}_{L3}}{3}$$

Overall Performance Rating (%) = _____

Requirements:

A candidate CBRN APR in accordance with the Statement of Standard for Chemical Biological Radiological and Nuclear (CBRN) Full Facepiece Air Purifying Respirators (APR), March 7, 2003 with Revision 2, April 4, 2003 must obtain an Overall Performance Rating greater than or equal to 70% to meet the Communication requirement.

Other types of CBRN RPD may be tested for Communication performance using this procedure: Refer to the primary Statement of Standard for that particular CBRN RPD being tested for the Communication performance requirements.

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1. Reproduce 10 Times for each of the 10 MRT Trials

MRT # _____

Listener # 1

Please Circle: Listener # 1 Masked Unmasked; Speaker # _____ Masked Unmasked

1. Number of Words Spoken Correctly (MRT/Sheet# _____) = _____

2. Adjusted Score =
$$\frac{\text{Number of Correct Listener Responses} - \text{Number of Wrong Listener Responses}}{5}$$

Adjusted Score (Listener # 1) (MRT/Sheet# _____) = _____

3. % Correct = (Adjusted Score/ Number of Words Spoken Correctly) * 100

% Correct (Listener # 1) (MRT/Sheet# _____) = _____

Listener # 2

Please Circle: Listener # 2 Masked Unmasked; Speaker # _____ Masked Unmasked

1. Number of Words Spoken Correctly (MRT/Sheet# _____) = _____

2. Adjusted Score =
$$\frac{\text{Number of Correct Listener Responses} - \text{Number of Wrong Listener Responses}}{5}$$

Adjusted Score (Listener # 2) (MRT/Sheet# _____) = _____

3. % Correct = (Adjusted Score/ Number of Words Spoken Correctly) * 100

% Correct (Listener # 2) (MRT/Sheet# _____) = _____

Listener # 3

Please Circle: Listener # 3 Masked Unmasked; Speaker # _____ Masked Unmasked

1. Number of Words Spoken Correctly (MRT/Sheet# _____) = _____

2. Adjusted Score =
$$\frac{\text{Number of Correct Listener Responses} - \text{Number of Wrong Listener Responses}}{5}$$

Adjusted Score (Listener # 3) (MRT/Sheet# _____) = _____

3. % Correct = (Adjusted Score/ Number of Words Spoken Correctly) * 100

% Correct (Listener # 3) (MRT/Sheet# _____) = _____

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2. Average Unmasked and Average Masked % Correct Scores shall be calculated for each individual listener

$$\text{Average Unmasked \% Correct Score (Listener ____)} = \frac{\% \text{ Correct}_{(\text{Unmasked } 1)} + \% \text{ Correct}_{(\text{Unmasked } 2)} + \% \text{ Correct}_{(\text{Unmasked } 3)} + \% \text{ Correct}_{(\text{Unmasked } 4)} + \% \text{ Correct}_{(\text{Unmasked } 5)}}{5}$$

$$\text{Average Unmasked \% Correct Score (Listener ____)} = \underline{\hspace{2cm}} \%$$

$$\text{Average Masked \% Correct Score (Listener ____)} = \frac{\% \text{ Correct}_{(\text{Masked } 1)} + \% \text{ Correct}_{(\text{Masked } 2)} + \% \text{ Correct}_{(\text{Masked } 3)} + \% \text{ Correct}_{(\text{Masked } 4)} + \% \text{ Correct}_{(\text{Masked } 5)}}{5}$$

$$\text{Average Masked \% Correct Score (Listener ____)} = \underline{\hspace{2cm}} \%$$

3. Each individual listener's Average Masked % Correct Score shall be divided by their Average Unmasked % Correct score to calculate a Performance Rating using the equation:

$$\text{Performance Rating \% (Listener ____)} = \left(\frac{\text{Average Masked Score (Listener ____)}}{\% \text{ Average Unmasked Score (Listener ____)}} \right) \times 100\%$$

$$\text{Performance Rating \% (Listener ____)} = \underline{\hspace{2cm}} \%$$

4. Use Performance Rating % of each Listener to Determine the Overall Performance Rating of the RPD.

$$\text{Overall Performance Rating (\%)} = \frac{\text{Performance Rating (\%)}_{L1} + \text{Performance Rating (\%)}_{L2} + \text{Performance Rating (\%)}_{L3}}{3}$$

$$\text{Overall Performance Rating (\%)} = \underline{\hspace{2cm}}$$

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Revision History

Revision	Date	Reason for Revision
0	15 September 2004	Historic document
1.1	22 December 2005	Update header and format No changes to method